ITSF 2022 – Dusseldorf

Digital Substation journey and the need for speed...and time sync

7-10 Nov 2022

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Specialist in Digital & Smart-Grid Development

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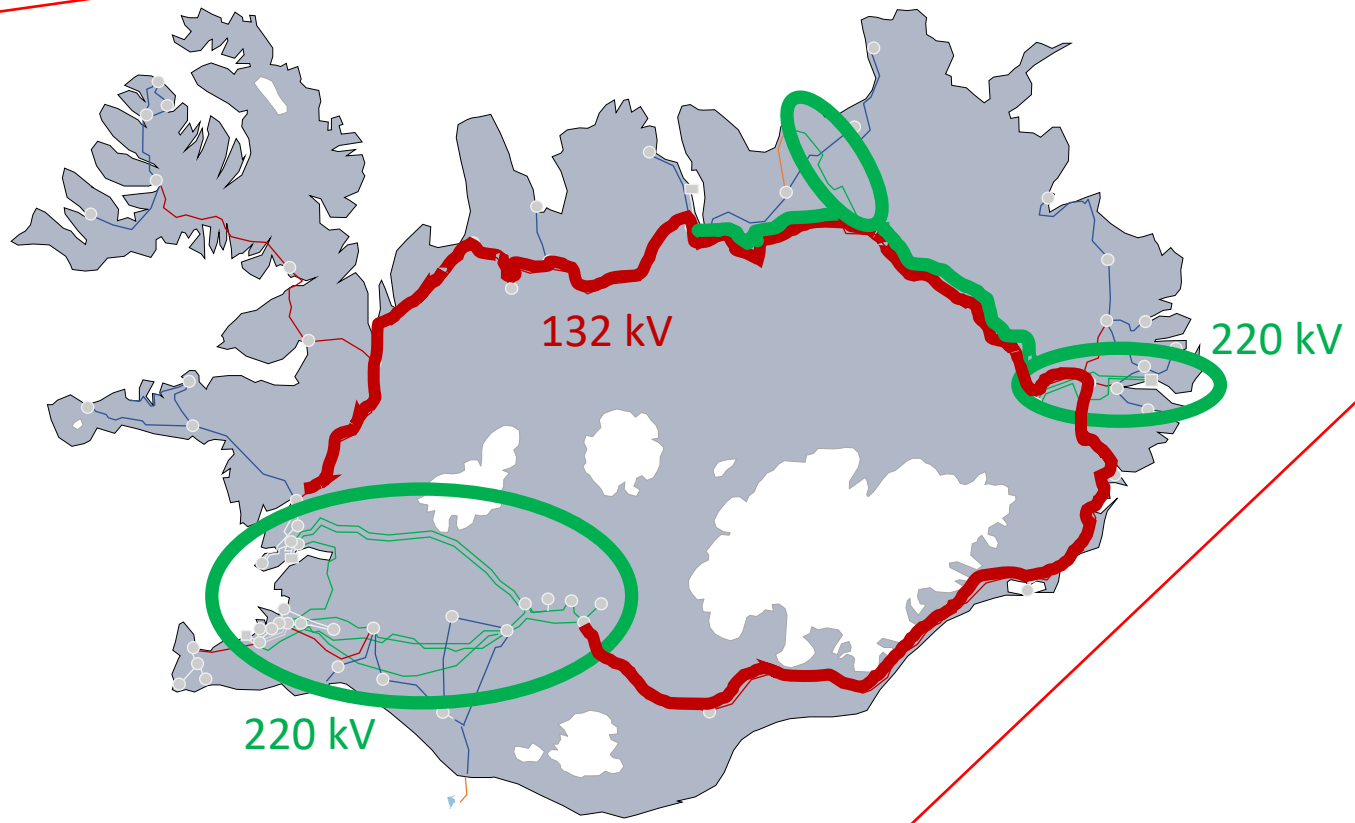
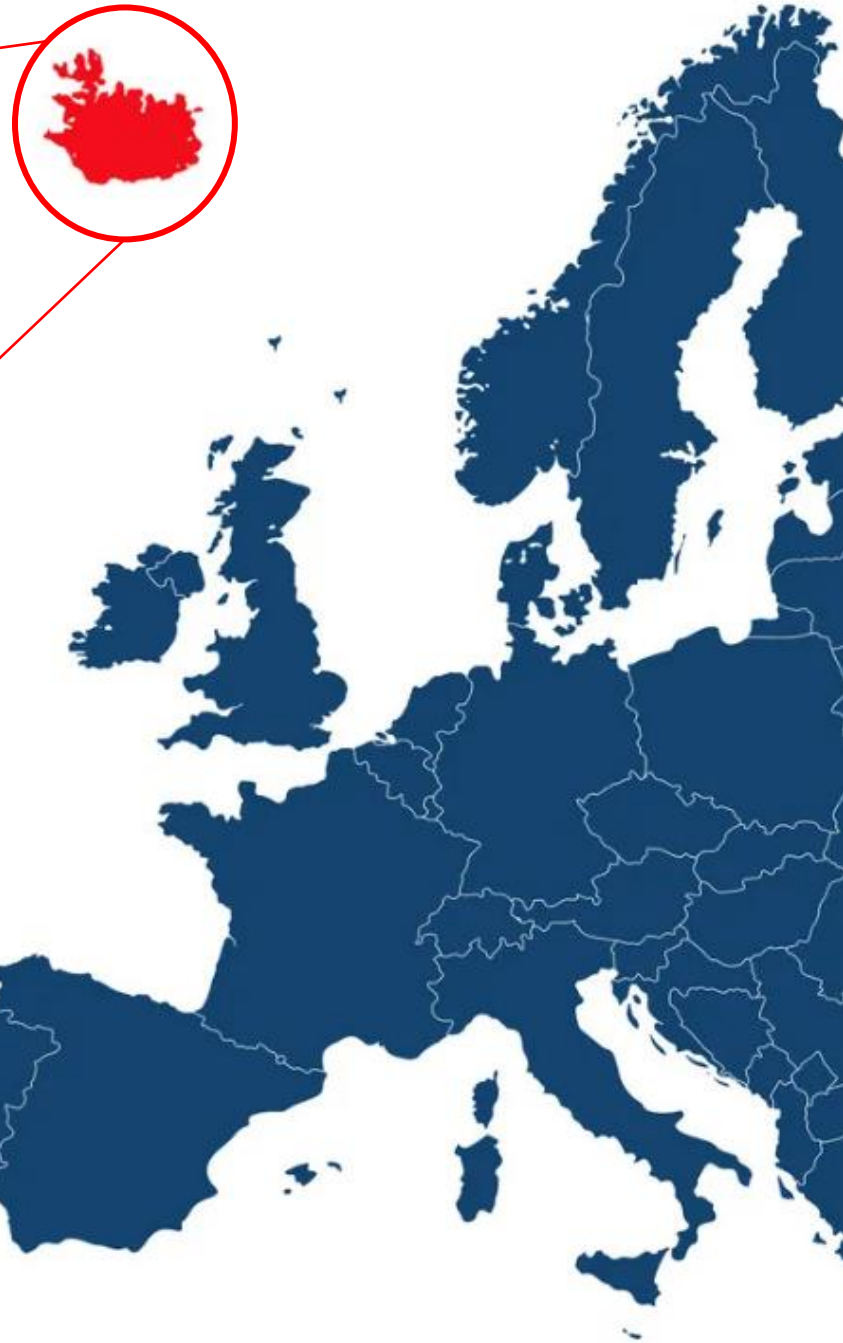
Icelandic Transmission System





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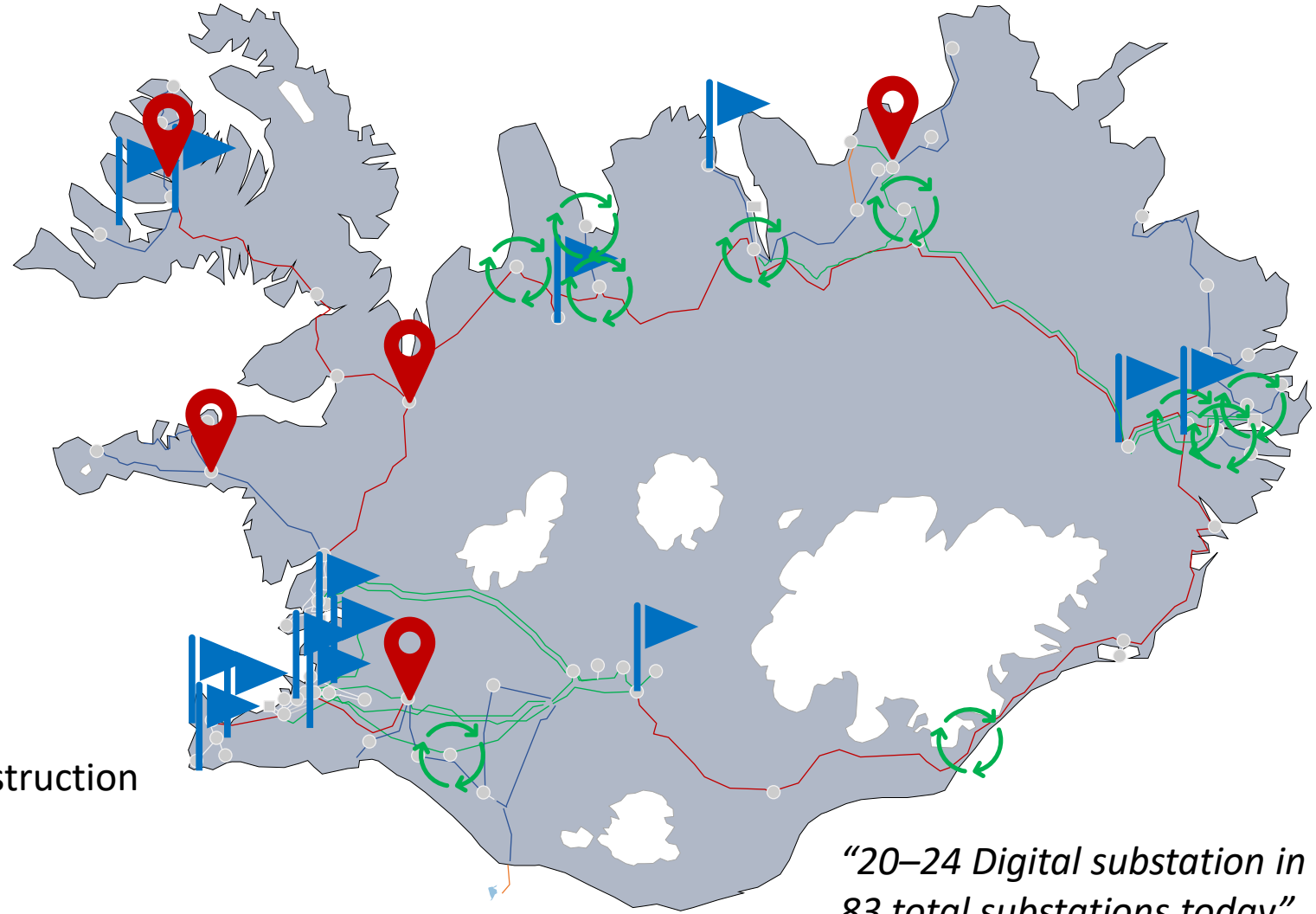
Digital Substation overview



Oct 2022

In Operation

In design / construction

2-5 year plan

“20–24 Digital substation in operation in 2025, 83 total substations today”

Wide-Area-Monitoring & Control -System

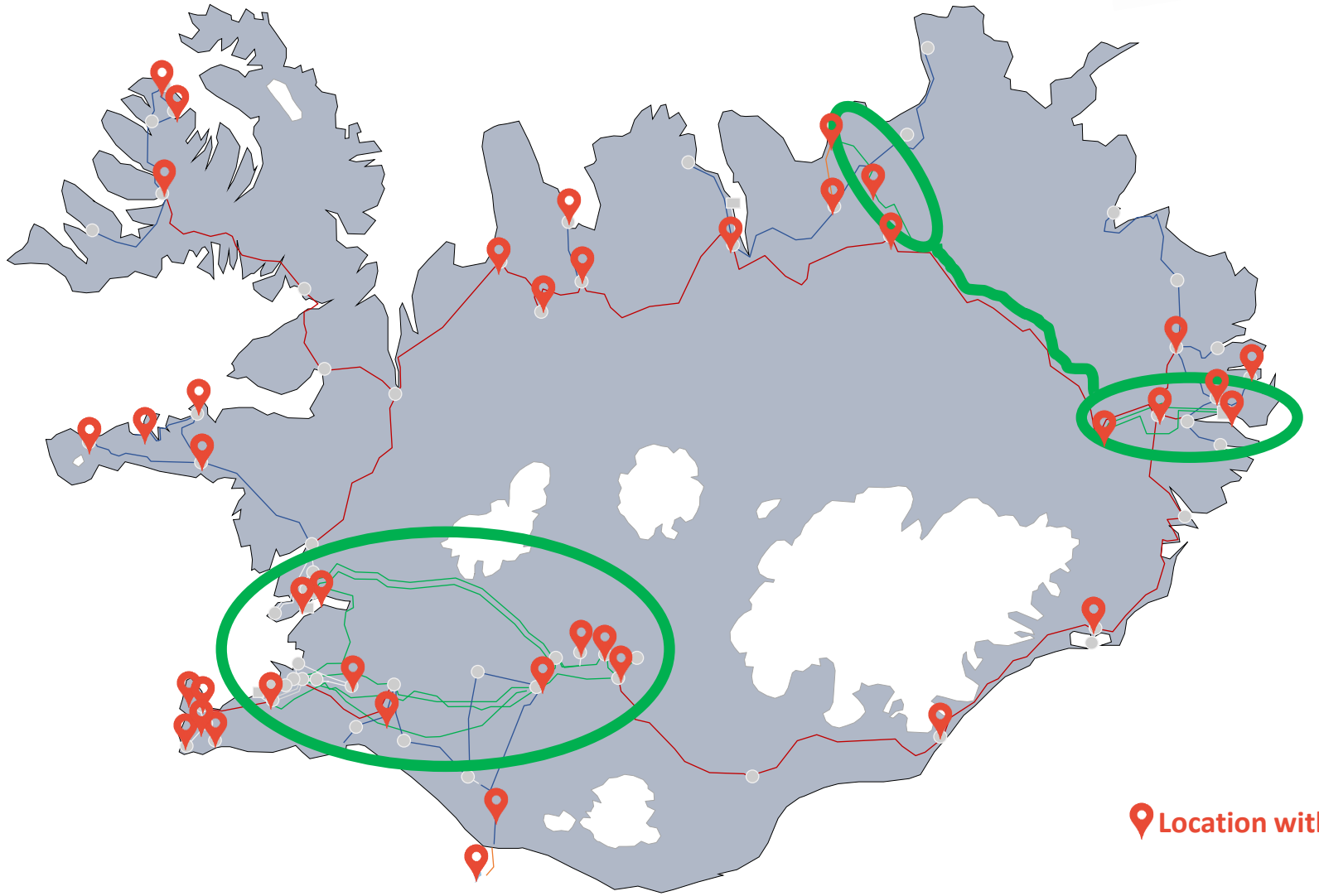
Extensive WAMS monitoring & records (~100 PMUs)

Landsnet & grid-stakeholders willing to trial innovation

Multiple Wide-Area-Control-Schemes in operation to increase system stability and reliability

Good quality and secure communications network operated by

Orkufjarskipti



Location with PMUs

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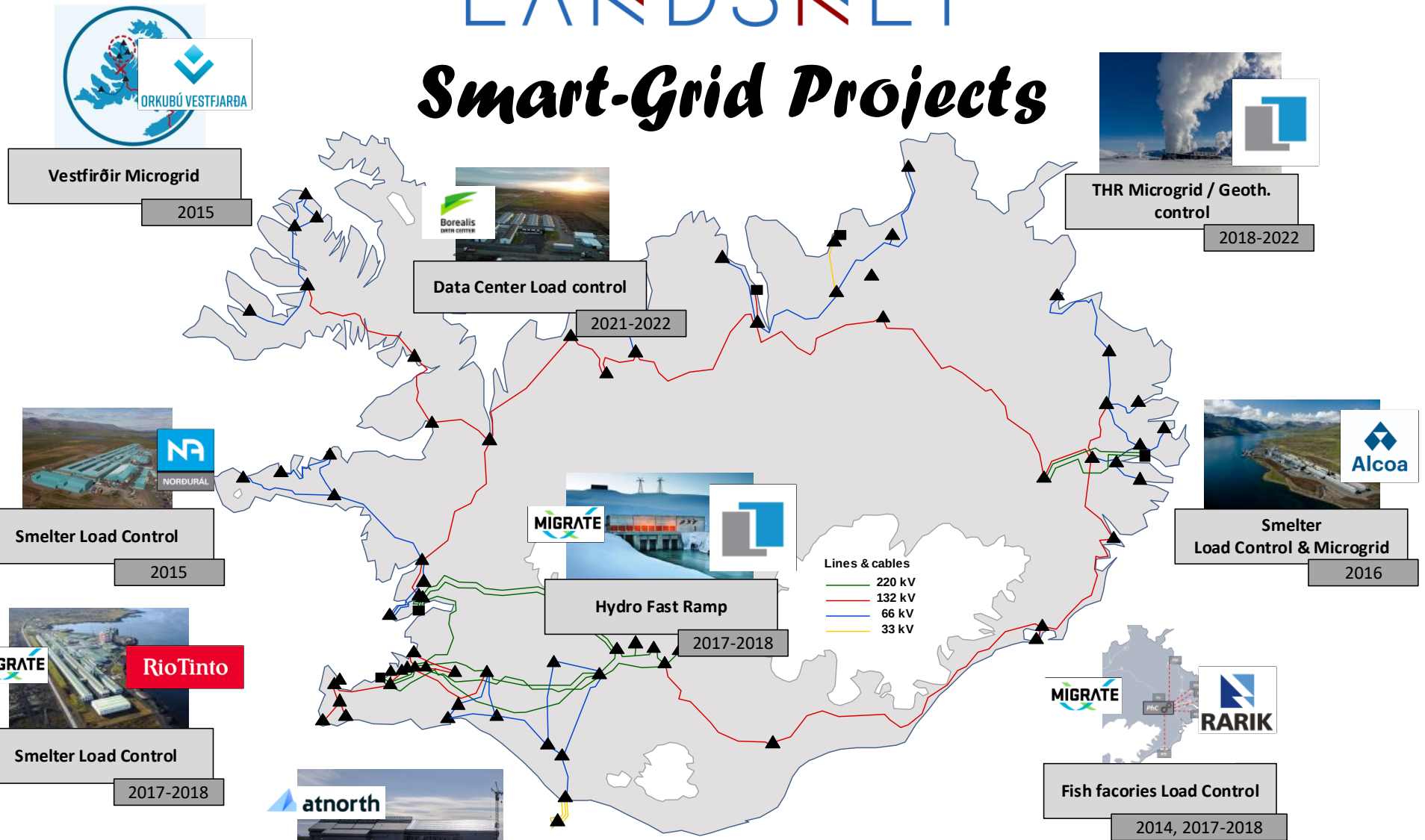
Smart-Grid Projects



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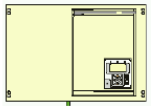
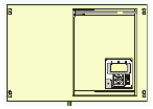
Substation - Bay

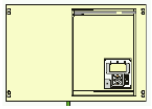
Conventional Substation

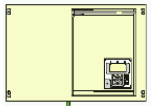
Protection: Distance 

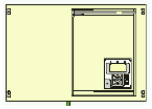
Protection: Differential 

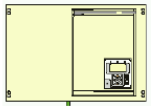
Bay Controller 

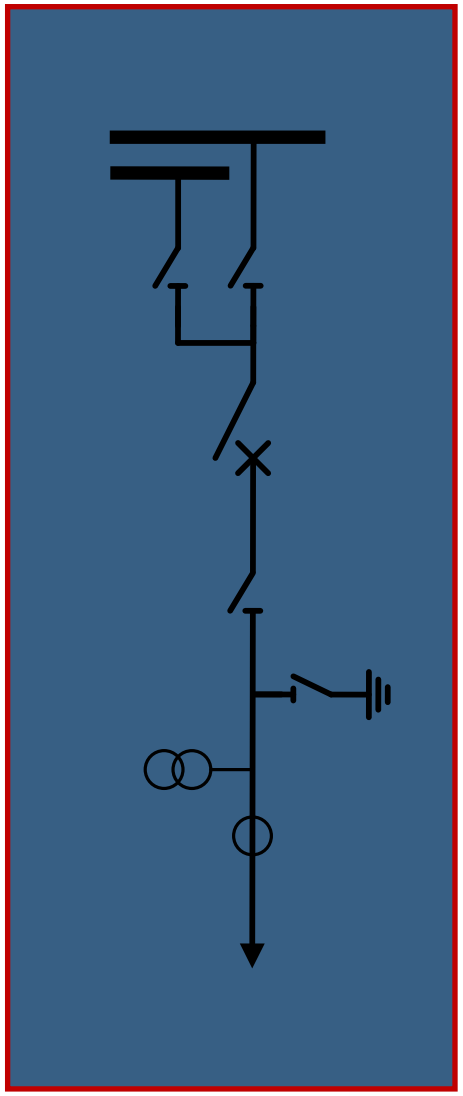
Revenue Meter 

PMU 

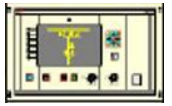
Point on Wave 

Transformer AVR 

Power Quality 



Digital Substation



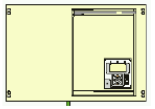
IED Main 1

IED Main 2

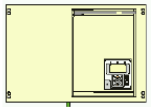
f(x)

- Protection
- Control
- PMU
- AVR
- ?Revenue Meter?

?Revenue Meter?



MU+SCU Main 1



MU+SCU Main 2

f(x)

- Sampled Values
- I/O interface
- Point on Wave
- ?Power Quality?
- ?Time-domain?

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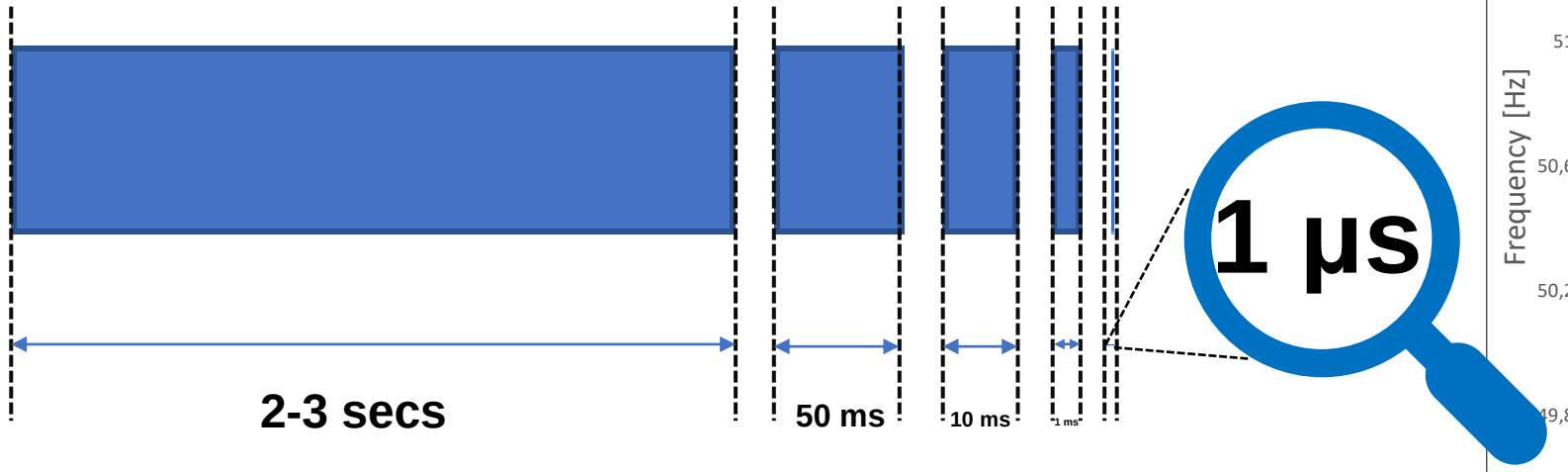
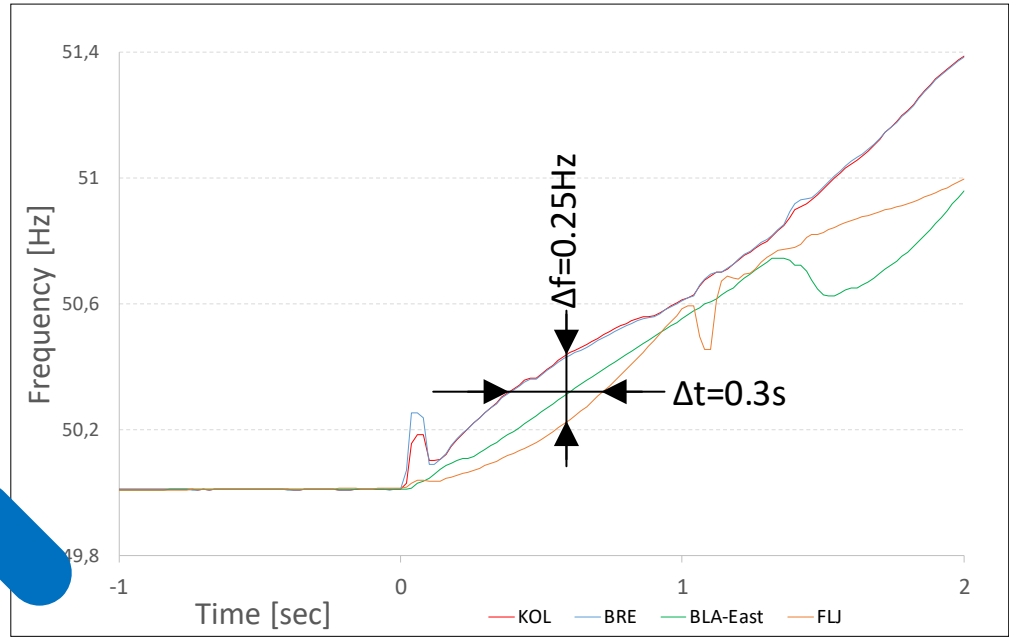
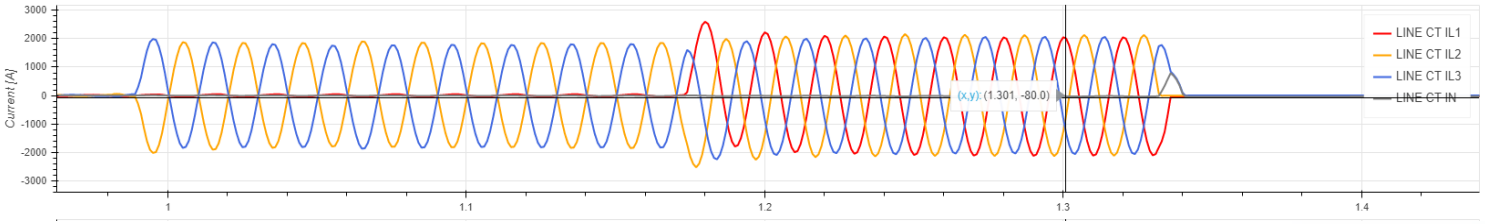
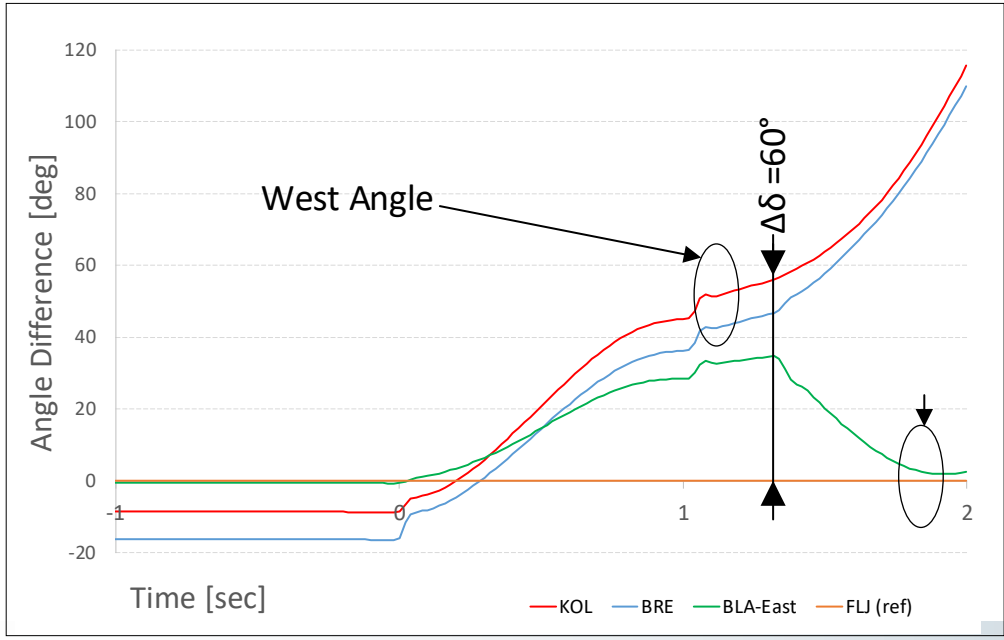
The need for "light" speed





Sampled Values (SV) from different A/D converters must have 1 µs coherency to avoid phase errors which could cause maloperations of protections





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Time protocols

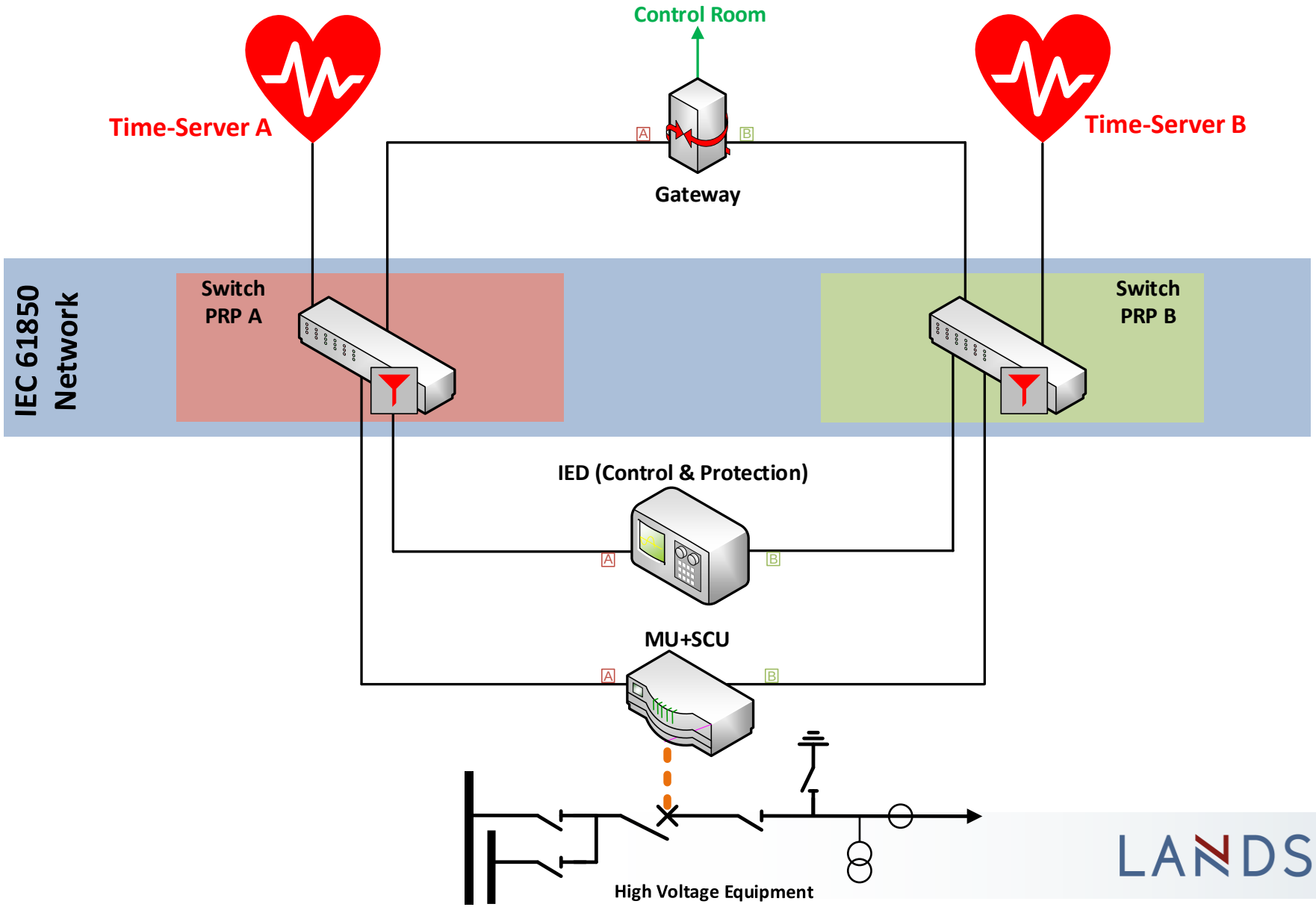
Time Synchronization System	Typical Accuracy	Uses Ethernet Network	Ambiguity
IRIG-B	10 µs - 1 ms	No – own wiring needed	1 year (extension available)
1PPS	1 µs	No – own wiring needed	1 second
Serial ASCII	1 ms	No – own wiring needed	None
NTP	1 ms - 10 ms	Yes	None
PTP (IEEE 1588)	1 µs	Yes	None

Precision Time Protocol (PTP, IEEE 1588)

- "µs accuracy“ needed for Sampled Values and PMU data
- Essential in Digital Substations!

Digital Substation Network Architecture

Virtual segregation of station- & process bus (same subnets)



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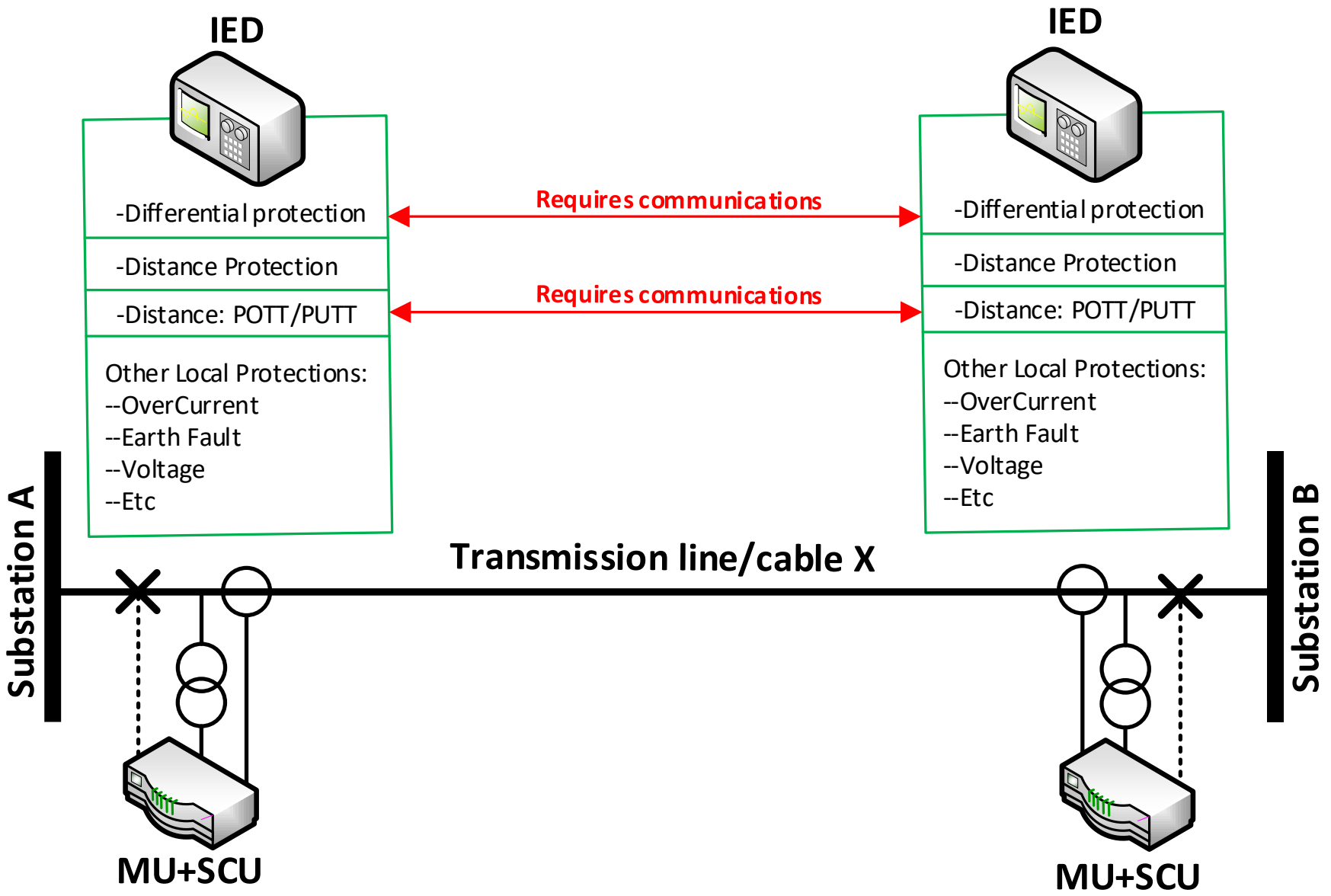
Digital Substation Protection – Time dependancy



GNSS?

Mother Nature

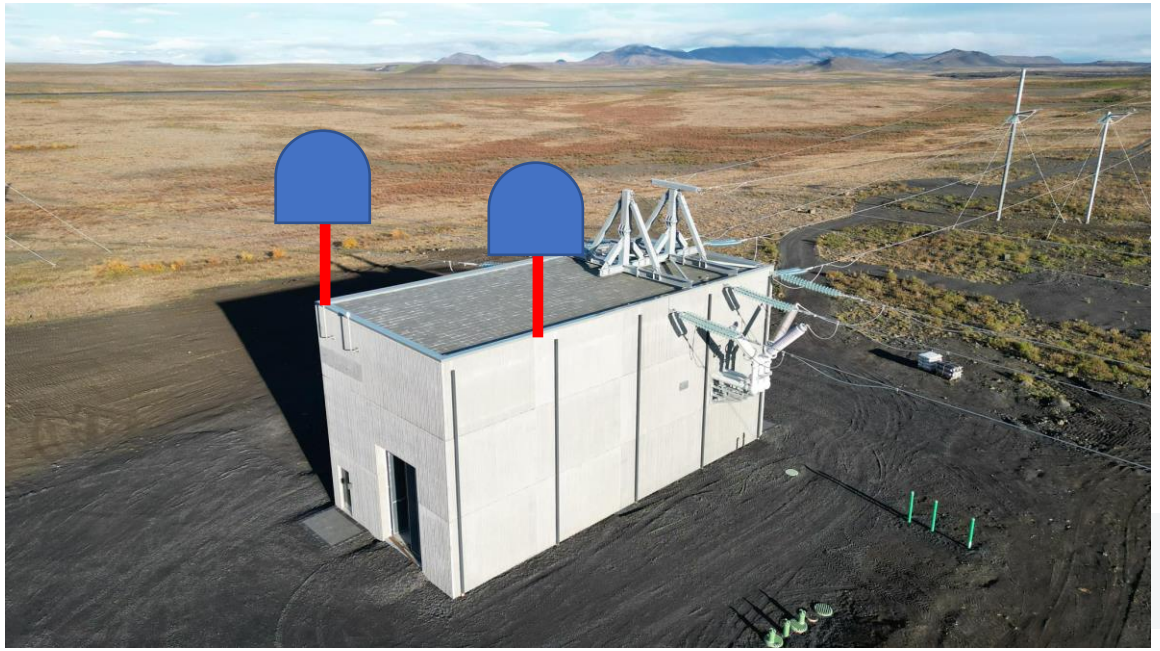
Weather

Geothermal

Volcano

Criminal/Warfare

Signal Spoofing



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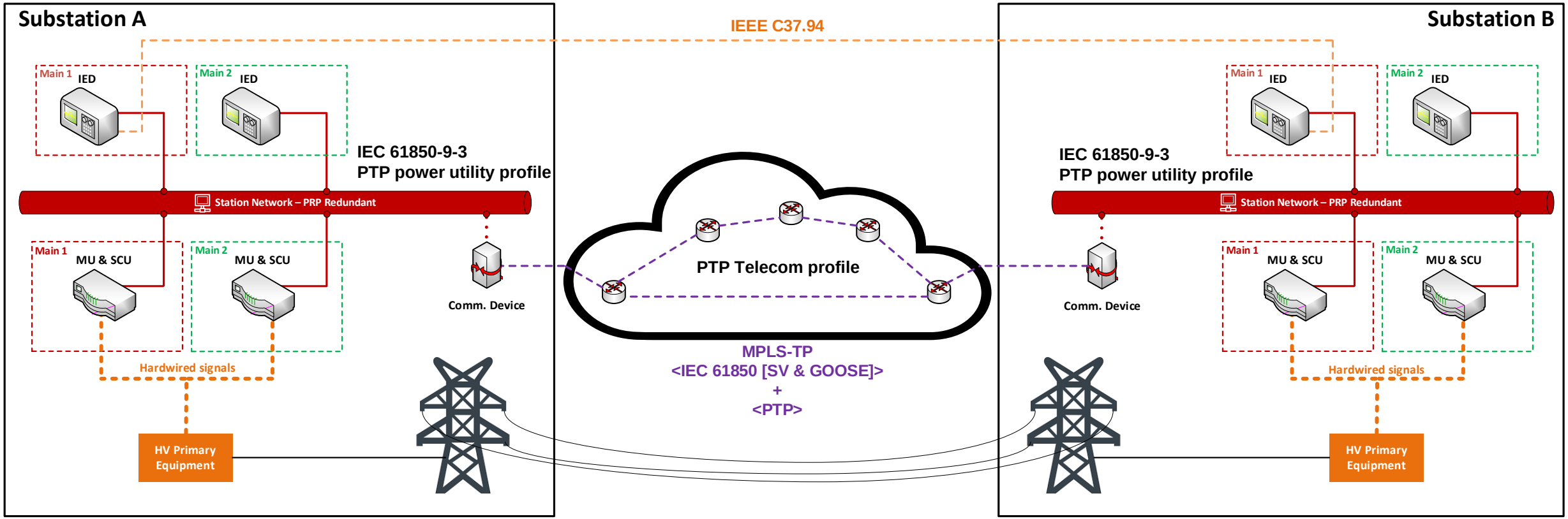
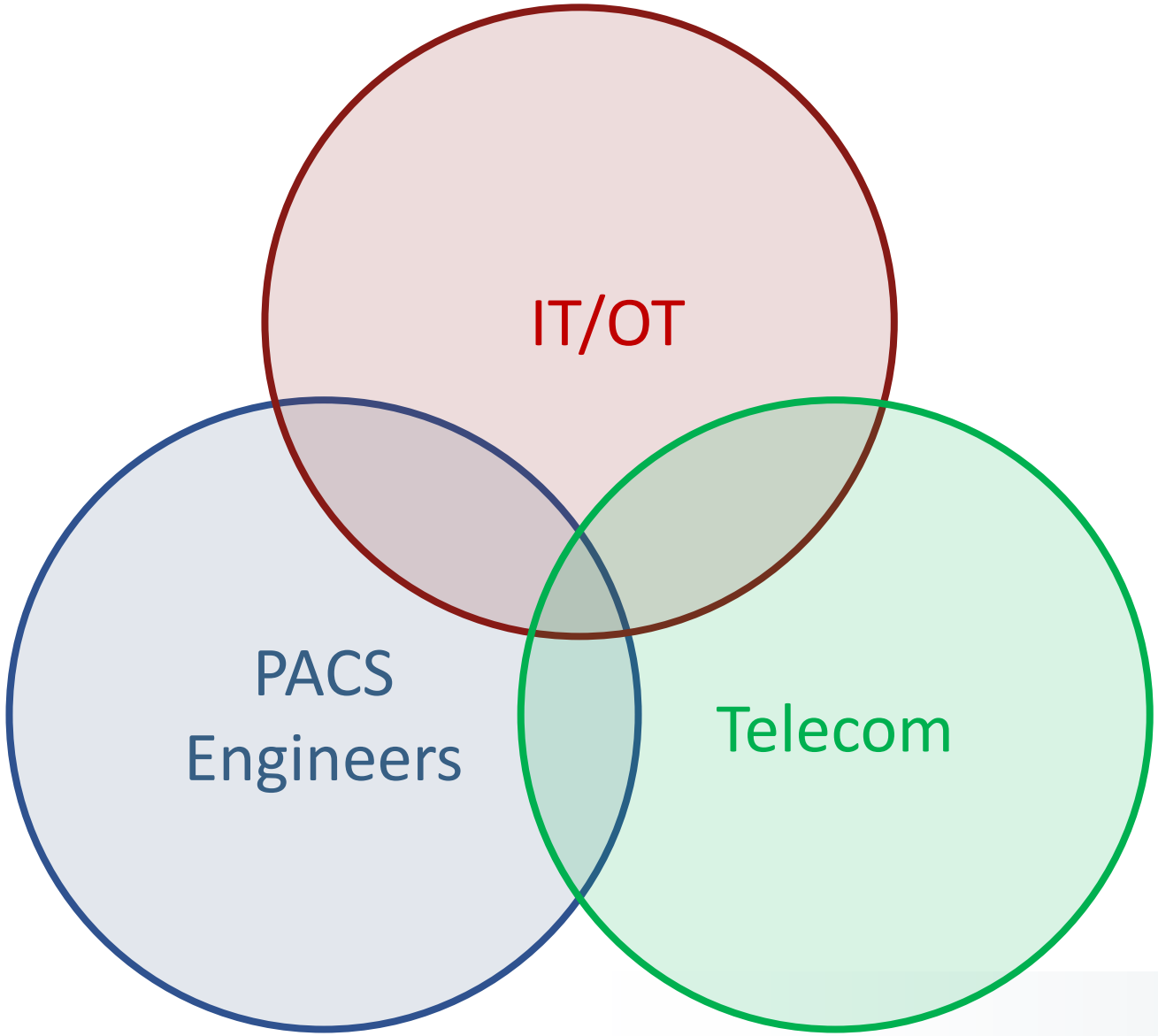
Substation to Substation Communications with IEC 61850

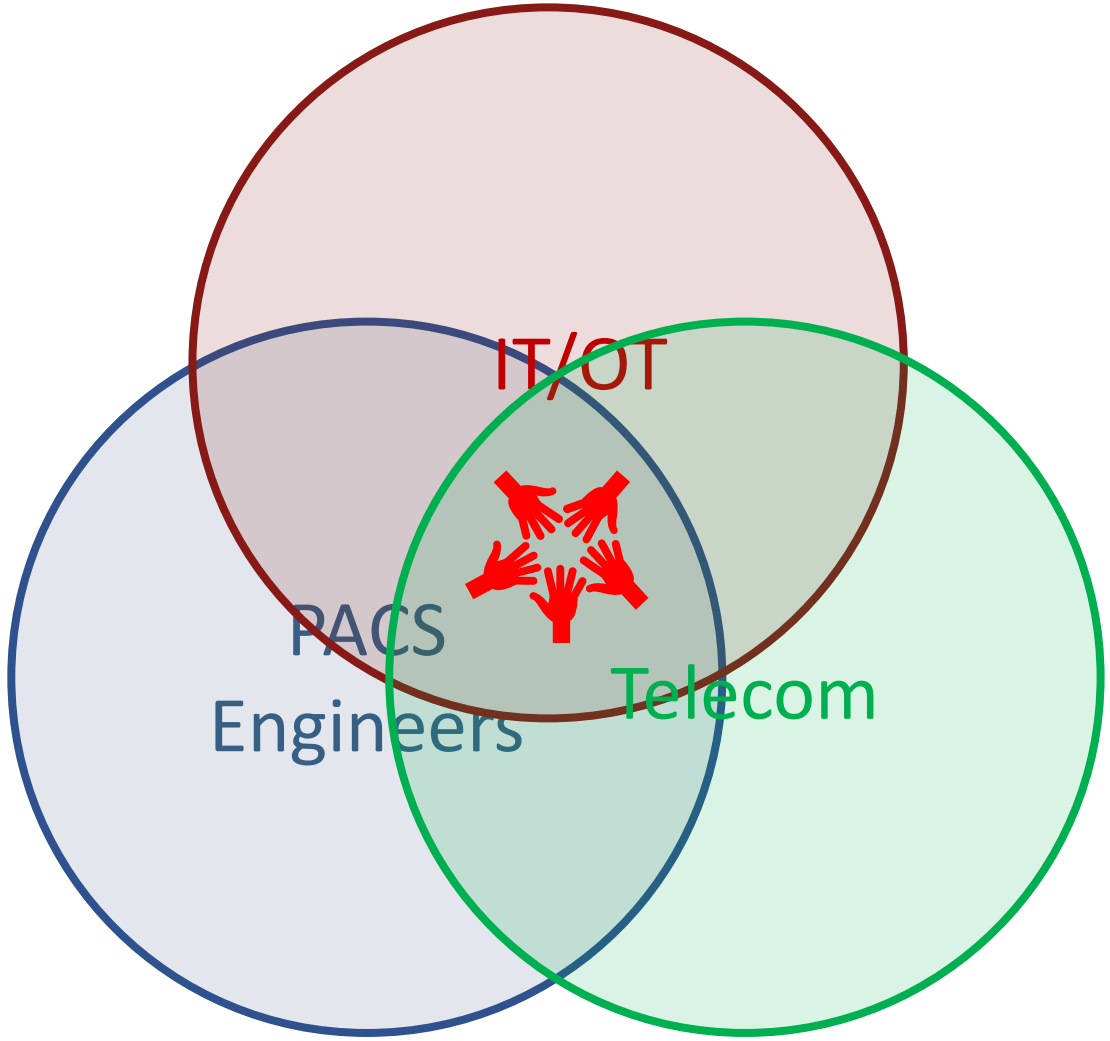
- Explore more sustainable way to share IEC 61850 data between substations.
- Land-based distribution of PTP from atomic clocks (primary), local GPS clock (secondary)



Digitalization drives the need for closer collaboration



Digitalization drives the need for closer collaboration

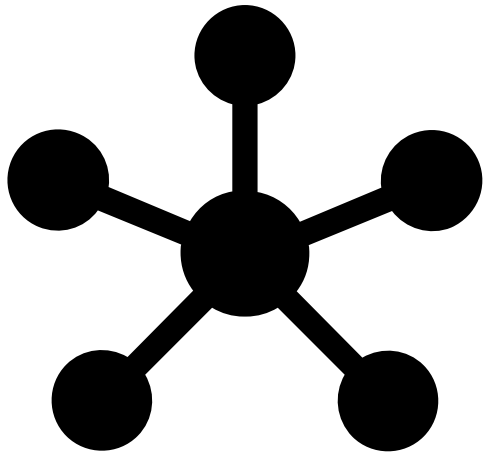


Wrap-up

“System thinking rather than modular (Top down)”

Learn by doing
> Mistakes are part of journey <

Further collaboration
> Key for success<



Time-Sync is the heartbeat
> Further testing and improvements <

Wide-area communication
> Enhance protection, smart control and time sync <

System testing
> Comprehensive system and sync tests <

“The future is DIGITAL, and the opportunities are endless”

Birkir Heimisson
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vimeo
The Digital future of Transmission Systems
https://vimeo.com/641137942